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SEMI-ANNUAL STATUS REPORT
RESEARCH GRANT NGR-03-041-001
17 July 1967

I. STATEMENT OF RESEARCH ACCOMPLISHED

This program of research* involves interpretation of physiological responses in free-roaming animals with the use of telemetry techniques. Progress from the initiation on 1 October 1966 has dealt with the development of radio transmission techniques of sufficient range to allow the study of physiological responses at such a distance that the investigator does not noticeably modify the behavior of an animal under study. We have been concerned, specifically, with the investigation of characteristic temperature fluctuations with the intent of correlating these fluctuations with the onset of novel stimuli and the subsequent understanding of behavior which may result from these stimuli. We are particularly interested in temperature fluctuations on the order of .01°C differences which occur with time constants of approximately 20 seconds. It is known from the work of Russian physiologists that novel stimuli can be described in terms of an "orientation reaction." These are observed by (a) an increase in the sensitivity of the sense organs, (b) postural changes, (c) electroencephalographic changes toward faster and lower amplitude activity, (d) local vasoconstriction and vasodilation at the body surfaces, (e) galvanic skin reactions, and (f) changes in respiration and heart rate.

We have been successful in the development of radio equipment to accomplish transmission of the desired data. During the month of June 1967 this equipment was applied to the study of free-roaming animals in the Serengeti National Park, Tanzania, East Africa. The devices were applied to both the African lion, a major predator in the Serengeti, and to a wild zebra in the Ngorongoro Crater. The work on lion predation is under investigation by Dr. George Schaller who assisted in the interpretation of results obtained. Work with zebra was done in collaboration with Dr. William Hamilton, III. The following is a summary of these initial experiences in telemetry of body temperature from untethered wild animals in their natural habitat:

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1. On June 9 an adult male lion was immobilized and a one-ounce tracking transmitter was affixed to the neck with a loose collar. The transmitter operated at 148.5 mc and provided a practical range of three to twenty miles under field conditions. The animal was followed throughout the hours of darkness for the following four days during which time he travelled approximately 17 miles, visited two water holes and scavenged food from a wildebeest killed by hyenas. On the fourth day he was joined by another male lion and we were unable to locate him that evening. We suspect that the second lion may have removed the antenna from the instrumented animal. During the four days of operation, we were able to establish tracking techniques by both aircraft and land vehicles sufficient to warrant an attempt at body temperature telemetry.

2. On the 18th of June an adult female was located and immobilized in the high grass plains about 18 miles from the Serengeti Park headquarters at Seronera. She was equipped with a transmitter for sensing surface body temperature. The sensor was placed in the connective tissue under the skin on the dorsal surface of the neck. A small incision was made for the probe and then closed with a suture after the probe was inserted. Subdermal temperature was taken continuously for the next 48-hour period, both by automatic recorder and by notebook at 5-minute intervals. During this period we found unmistakable evidence that novel stimuli do cause a major shift in surface body temperature. A sample of the actual record is enclosed as Figure 1. On the morning of the third day the data indicated that the probe was sensing ambient temperature rather than body temperature and we were able to verify during daylight the fact that the probe had been dislodged. The collar was inverted which placed the antenna between the lion's forelegs. Although the transmission range was reduced we were able to reestablish contact with the animal by radio on subsequent occasions. The initial attempt to remove the equipment was unsuccessful because of the high grass which deflected the capture syringe.

3. Great herds of wildebeest (gnu) and zebra constitute the major prey animals of East Africa. The E. burchelli is one of the two species of wild horse found in great abundance in this equatorial plateau region. Dr. Hamilton's work on thermoregulation with regard to coloration in animals led us to consider the zebra as an animal in which the black and white stripes might serve to aid in the control of body temperature. We were somewhat surprised to find that temperature differences under tanned zebra hide showed as much as 8°C difference when

a probe was placed under the white stripe vs. the black stripe in sunlight. Our intent in transmitting surface body temperature information, then, from a wild zebra was to establish whether radiation was a factor in the thermoregulatory behavior of these animals.

On June 27 we successfully immobilized a young male zebra in the Ngorongoro Crater some 88 miles from the Serengeti Park headquarters. Surface body temperature was obtained for the next 48-hour period in the same manner as described above, together with movement behavior, weather, wind and sunlight data. The data obtained strongly suggests that the zebra employs radiation in the maintenance of the relatively constant body temperature and that behavior in part can be understood from these considerations. A research note to be submitted to Science is in preparation.

II. CONCLUSIONS AND RECOMMENDATIONS

The data obtained from field experiments has not yet been thoroughly analyzed; however, we can conclude at this time that sensory phenomena of interest in an animal can be studied with the use of surface body temperature telemetry. It is too early to state that such techniques will demonstrate major new insight into how an animal reacts to its physical and social environment by such methods. There is, however, every reason to believe that the method will prove to be productive. We feel that continuation of this work is strongly recommended in view of the fact that the technique has been established and that the initial application to unrestrained animals has developed new and heretofore unobtainable information.

Signed Howard A. Baldwin

Howard A. Baldwin
Principal Investigator
Sensory Systems Laboratory

Date 17 July 1967

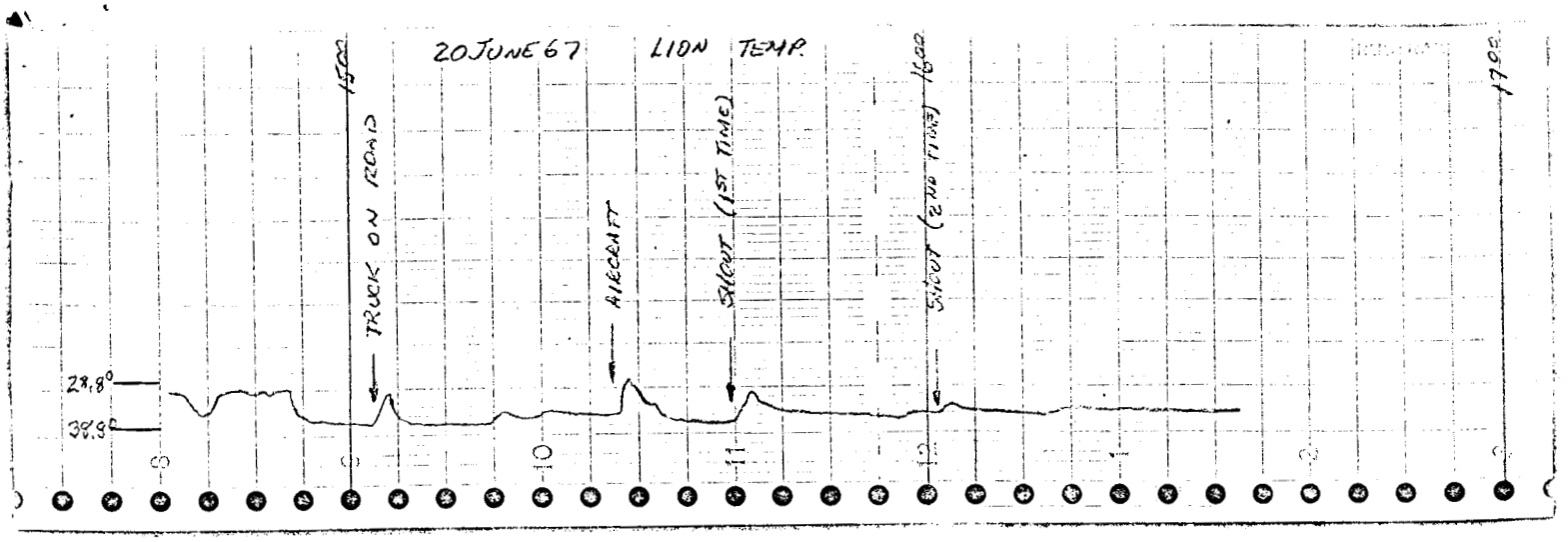

FIGURE 1

SUBDERMAL TEMPERATURE IN A FREE-ROAMING LION BY TELEMETRY

This represents a recording trace of temperature in the female lion correlated with acoustic stimuli noted by the observer. The lioness was not visible in the high grass when this record was made although she was probably within 100 yards of the observer. Temperature transients have a duration of two to three minutes and represent temperature decreases of as much as 10°C (maximum response to aircraft sounds). The response to two loud shouts by the observer shows accommodation. The vertical lines represent 5-minute intervals.

FIGURE 2

DR. GEORGE B. SCHALLER AND THE PRINCIPAL INVESTIGATOR ATTACHING A TRACKING TRANSMITTER TO A MALE LION.

Immobilization was accomplished with 78 mg. succinyl choline chloride on this animal. This allowed about 10 minutes of working time and complete recovery in about 25 minutes. The head is covered to reduce sensory input during immobilization and the net was provided to give some diversion to the lion in the event of early recovery.

FIGURE 3

AN ATTEMPT TO ADHERE THE TRANSMITTING COLLAR TO THE MANE

The transmitter collar is secured by rivets and hangs loosely on the neck. It is weighted so that the short whip antenna remains approximately vertical when the lion is on its feet. The small white object is a loading coil to electrically shorten the antenna. Here an attempt is being made to adhere the hair of the mane to the collar to keep the antenna in position.

FIGURE 4

Both tracking and temperature data were obtained with the same receiver and antenna system. All work was done from vehicles to reduce the hazard to personnel and stimulation to the animals under study. Practical ranges of operation appeared to be one to three miles from instrumented animals monitored in this manner. Ranges of 20 to 25 miles were obtained under line of sight conditions. (The use of light aircraft, for example, allows for the location of an animal transmitter within an area of 1200 square miles.)

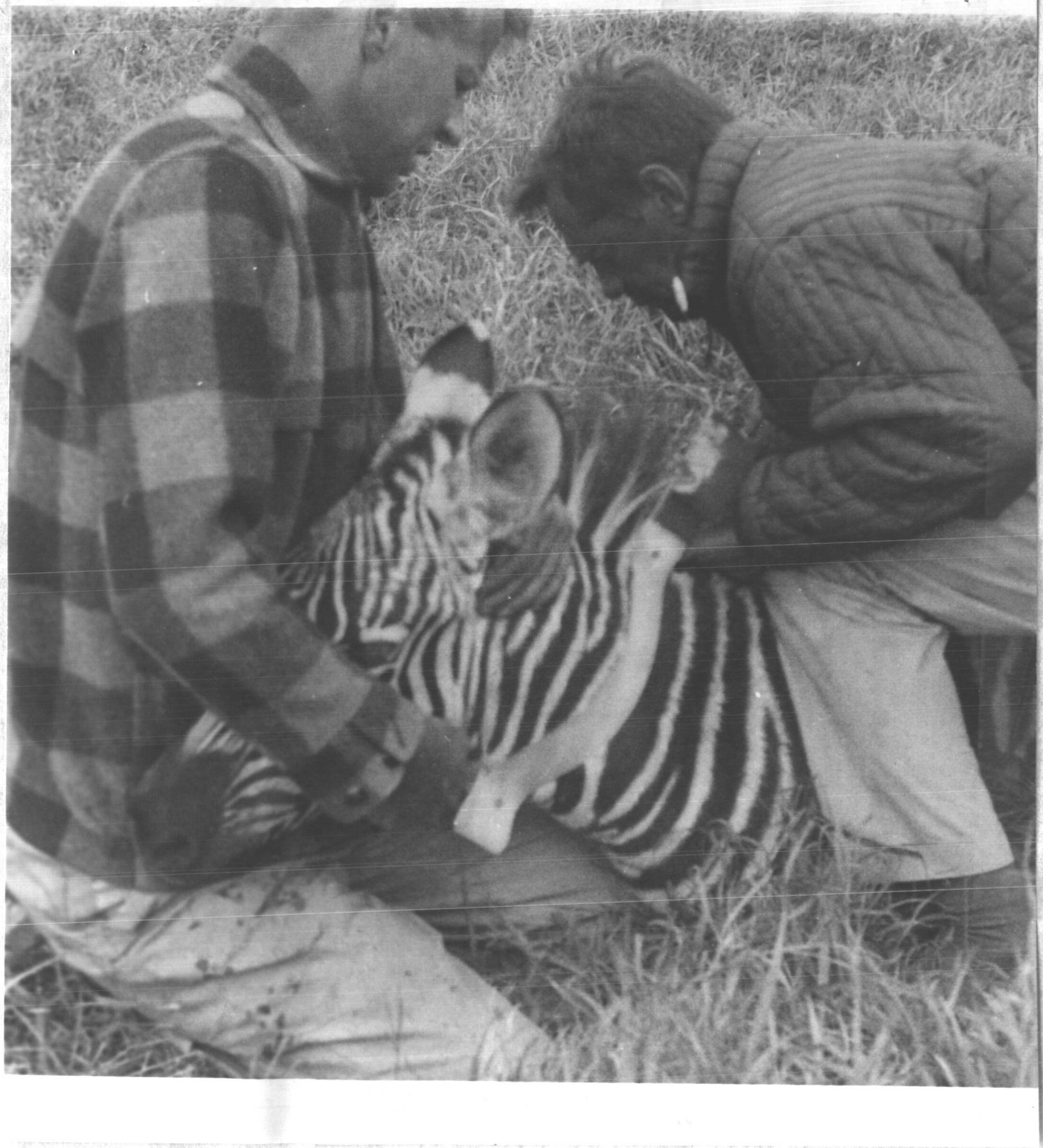

FIGURE 5

ATTACHING THE TEMPERATURE TRANSMITTER TO A YOUNG ZEBRA WITH DR. WILLIAM HAMILTON.

The collar consisted of two flat polyethylene bands. The transmitter was taped to the upper junction so as to provide as much height as possible. The temperature sensor was placed subdermally on the neck under one of the dark stripes.